IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

BASF CORPORATION, Plaintiff, v. JOHNSON MATTHEY INC., Defendant.	C.A. 14-1204-SLR-SRF

DECLARATION OF WILLIAM S. EPLING, PH.D.

I, William S. Epling, do hereby declare and state as follows:

1. I have been retained by Johnson Matthey Inc. ("JMI") to provide technical consultation and expert opinions in this case regarding United States Patent No. 8,524,185 (the "'185 patent").

2. I have been asked by counsel for JMI to provide expert opinion in connection with the technology of exhaust aftertreatment systems and the interpretation of certain claim terms of the '185 patent. I submit this declaration in support of JMI's Answering Claim Construction Brief. I have personal knowledge of the facts set forth in this declaration and, if called to testify as a witness, would do so.

3. I understand that patent claims are construed, or interpreted, as they would be understood by one of ordinary skill in the art of the patent at the time the patent application was filed. I understand that claim construction begins with looking at the language of the claim. I also understand that, beyond the claim language, the specification is considered the best guide to the meaning of a claim term. I also understand that claims are to be construed with reference to the intrinsic evidence in the specification and prosecution history, and extrinsic evidence, such as dictionaries and treatises.

4. I understand that a claim term is considered indefinite if, read in context of the specification, it does not inform a person skilled in the art about the scope of the invention with reasonable certainty. I also understand that simply because some claim language may not be precise does not automatically render a claim invalid. I also understand that functional claim language is not objectionable per se, but may be indefinite if the functional language is overly broad and vague.

I. QUALIFICATIONS

5. I am currently Professor of Chemical and Biomolecular Engineering at the University of Houston. I lead a research group that focuses on understanding, designing, and developing new and improved catalyst compositions to treat engine exhaust streams. Among the catalysts I design and develop are SCR catalysts. At the University of Houston, I have received funding to study engine-emission catalysts from General Motors, Cummins Inc., the National Science Foundation in conjunction with the Department of Energy, Shell, Aramco and Fiat Chrysler Automobiles. I have been on the faculty at the University of Houston since 2011.

6. Between 2005 and 2011, I was an Assistant Professor and then an Associate Professor at the University of Waterloo, where I also led a research group focused on understanding and engineering catalyst compositions to treat engine exhaust streams, including catalysts for the SCR of NOx. During this time I received funding from Cummins Inc., the Natural Sciences and Engineering Research Council of Canada, the Canada Foundation for Innovation, General Motors, and NxtGen Emissions Control, among other sources.

7. Between 2003 and 2005, I worked as a Technical Specialist at Cummins Inc., where I worked on NOx reduction catalysts, including lean NOx traps and SCR catalysts, as well as diesel particulate filters. My duties included developing techniques to measure catalyst performance, resolving how the reactions occur on a catalyst and their rates, and integrating these catalytic systems into engine exhaust after-treatment systems.

8. Between 2001 and 2003, I worked as a Senior Research Engineer at EmeraChem (formerly Goal Line Environmental Technologies). In this role I designed and developed lean NOx trap catalysts for applications in both the automotive and stationary power generation sectors.

9. Between 1997 and 2001, I held numerous positions in the field of catalysis for the abatement of pollutant emissions, including Assistant Professor of Chemical Engineering at The University of Alabama, Research Chemical Engineer at Goal Line Environmental Technologies, and Postdoctoral Researcher at Pacific Northwest National Laboratory.

10. I earned a Ph.D. in Chemical Engineering from the University of Florida in 1997. My thesis focused on the synthesis of fuel additives from coal-derived molecules, but as part of my Ph.D. work I also studied CH_4 oxidation catalysis for application to natural gas engine exhaust clean-up. I earned a B.S. in Chemical Engineering from Virginia Tech in 1992.

11. I have authored over 100 scientific articles, most in the field of catalysis for the abatement of pollutant emissions. I am an inventor of 3 U.S. Patents that relate to catalysts and systems for the treatment of engine exhaust streams.

12. By November 2008, when BASF filed its application for the '185 patent, I had over 10 years of experience in the field of catalysis for the abatement of pollutant emissions. More specifically, by this time I had more than 5 years of experience designing and developing new and improved catalysts to treat emissions from diesel engines, including catalysts for the SCR of NOx. Since then, I have continued to design and develop new and improved SCR catalysts.

13. A copy of my curriculum vitae is attached as Exhibit 1 to this declaration.

II. BACKGROUND OF THE TECHNOLOGY

14. I have reviewed BASF's Opening Claim Construction Brief, and the declaration of Dr. Mark Crocker submitted by BASF in support of its Opening Brief. I generally agree with

the description of the technology of exhaust aftertreatment systems in Section II of Dr. Crocker's declaration.

III. OPINIONS ON THE '185 PATENT'S FUNCTIONAL DESCRIPTIONS OF "MATERIAL COMPOSITION A" AND "MATERIAL COMPOSITION B"

15. I have reviewed the '185 patent claims and specification.

16. I note that several terms in the '185 patent claims are described in terms of function, rather than defined materials. These terms include:

(a) "material composition A effective for catalyzing NH3 oxidation" (Claim 1);

(b) "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" (Claim 1);

(c) "material composition further effective to catalyze SCR of NOx" (Claim 5); and

(d) "material composition B free from precious metal effective for catalyzing selective catalytic reduction (SCR) of NOx" (Claim 17).

17. In my opinion, a person of skill in the field of catalysis would not be able to determine with reasonable certainty the boundary of what materials are included within the phrase "material composition A effective for catalyzing NH3 oxidation" based on the disclosure in the '185 patent.

18. Most any material composition that has a metal or metal oxide component will, to some extent or other, catalyze the oxidation of ammonia. As one example, even steel lines, like the exhaust pipe itself, will catalyze the oxidation of ammonia to some degree under appropriate conditions. Even considering only the conditions typically encountered during operation of a diesel engine, there are an effectively limitless number of compositions that can catalyze the oxidation of ammonia. Any metal or metal oxide would, to some measurable extent, catalyze the oxidation of ammonia if used to treat diesel engine emissions. Some metals would be excellent ammonia oxidation catalysts, like platinum, but the vast majority would exhibit some measurable

level of function. A brief literature search reveals scientific publications discussing ammonia oxidation over cobalt (Ex. 2), cobalt oxide (Ex. 3), perovskite structures (Ex. 4), zirconia (Ex. 5), vanadia (Ex. 6), copper (Ex. 7), manganese (Ex. 7), manganese oxide (Ex. 8), chromium (Ex. 9), gold supported on a variety of oxides (Ex. 10), nickel oxide and iron oxide (Ex. 11) materials. Furthermore, in a review of SCR catalysts, *Busca et al., Chemical and mechanistic aspects of the selective catalytic reduction of NOx by ammonia over oxide catalysts: A review*, Applied Catalysis B: Environmental 18 (1998) 1-36 (Ex. 12), the authors state "It has been shown that all oxide catalysts that are active for SCR (reaction (3)) are also active for the oxidation of ammonia by dioxygen." Busca at 19.

19. I do not believe that the '185 patent claims or specification identify particular conditions under which "material composition A" must be effective for catalyzing ammonia oxidation, other than the broad operating conditions of an exhaust aftertreatment system. The '185 patent also does not define the level of function required to be considered "effective." Certain materials are known to oxidize ammonia under some conditions, but not under other conditions. For example, the '185 patent identifies that at elevated temperatures, copper-based SCR catalysts can also have appreciable ammonia oxidation activity. '185 patent at 12:45-48. Similarly, iron-based SCR catalysts, as well as vanadium-based SCR catalysts, both considered potential commercial SCR catalysts for automotive systems, oxidize ammonia under certain conditions. Furthermore, platinum-based catalysts are known to perform SCR catalysis in a certain temperature range, but are also known to perform ammonia oxidation.

20. In my opinion, the phrase "material composition A effective for catalyzing NH3 oxidation" could either encompass or not encompass certain materials, depending on the particular conditions and what degree of function is necessary to be considered "effective." In my opinion, a person of skill in this field would not be able to determine with reasonable certainty the boundary of which materials are included within "material composition A effective for catalyzing NH3 oxidation" and which materials are not based on the disclosure in the '185

patent. Therefore, in my opinion the phrase "material composition A effective for catalyzing NH3 oxidation" is indefinite.

21. In my opinion, a person of skill in the field of catalysis would not be able to determine with reasonable certainty the boundary of what materials are included within the phrase "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" based on the disclosure in the '185 patent. The '185 patent provides no standard to determine whether any particular composition is effective enough in catalyzing SCR to be considered a "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" or a "material composition B free from precious metal effective for catalyzing selective catalytic reduction (SCR) of NOx."

22. There are also a practically limitless number of materials that would, to some extent, catalyze SCR of NOx, even within the normal operating conditions of an exhaust aftertreatment system. I have reviewed the specific materials identified as effective to catalyze SCR of NOx in the '185 patent's specification and in dependent claims 6, 8, 10, 11, and 13. '185 patent at 6:56-8:2, 20:6-28. I agree that these materials can be effective to catalyze SCR of NOx under certain conditions. However, the compositions identified in the '185 patent are not an exhaustive list of compositions that are capable of catalyzing the oxidation of ammonia or the SCR of NOx. Moreover, while the '185 patent identifies many general categories of SCR compositions (for example iron and copper zeolites), many specific compositions within those general categories exhibit little to no SCR function. I have synthesized specific copper zeolite compositions for use as SCR catalysts, for testing and research, which displayed no SCR function under certain conditions within the normal range of exhaust from a diesel engine. Changing the preparation conditions ultimately led to catalysts that did perform the SCR reaction. In practice, it takes years to design, develop, and optimize a suitable catalyst, and this includes SCR catalysts. Merely knowing that a composition is an iron or copper zeolite is not enough to know whether it exhibits substantial SCR function.

23. I do not believe that the '185 patent claims or specification identify particular conditions under which "material composition B" must be effective for catalyzing SCR of NOx. The '185 patent also does not define the level of function required to be considered "effective." In my opinion, to be reasonably certain of what materials are encompassed within the phrase "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx," the '185 patent would have to provide some standard for determining if a material composition is "effective" to catalyze that reaction. In the absence of such information, a person of skill in this field would not be able to determine with reasonable certainty which materials are encompassed within this phrase, and which are not. For example, certain compositions having platinum can catalyze the SCR reaction, but under rather limited conditions. Similarly, depending on temperature, specific iron-based zeolites or copper-based zeolites may be preferred as SCR catalysts, with copper outperforming iron at low temperatures (<300C) and iron outperforming copper at the higher temperatures. These catalysts' performances are very temperature and oxygen concentration dependent. Some will catalyze the SCR reaction only at the low end of the normal range of operating temperatures, others only at the high end of the range, and yet others throughout.

24. In my opinion, the phrase "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" could either encompass or not encompass certain materials, depending on the particular conditions and what degree of function is necessary to be considered "effective." In my opinion, a person of skill in this field would not be able to determine with reasonable certainty the boundary of which materials are included within "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" and which materials are not based on the disclosure in the '185 patent. Therefore, in my opinion the phrase "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" is indefinite.

25. For the same reasons, in my opinion the phrase "material composition further effective to catalyze SCR of NOx" in claim 5 of the '185 patent is indefinite.

26. For the same reasons, in my opinion the phrase "material composition B free from precious metal effective for catalyzing selective catalytic reduction (SCR) of NOx" in claim 17 of the '185 patent is also indefinite. The additional language "free from precious metal" present in claim 17 would not permit a person of skill in this field to determine with reasonable certainty the boundary of which materials are encompassed by this phrase, and which materials are not. This additional language identifies materials that are not covered by the claim (materials containing precious metal), but does not identify the boundary of which materials are covered by the claim.

27. There are objective standards in this field that the '185 patent could have provided to permit a person of skill in this field to determine which materials are and are not encompassed by the "material composition A" and "material composition B" phrases. For example, scientists and engineers in this field frequently refer to the "percent conversion" of a catalyst. This refers to the percent of a chosen reactant that is converted to the desired product under defined conditions that can be repeated. A standard way to reasonably quantify the oxidative function of a catalyst is to measure the percent conversion of propylene oxidation under a set temperature, substrate, gas compositions, and exhaust flow rate. In this way, the function of numerous catalysts can be objectively compared—*i.e.*, the percent conversion of each is measured under set, defined conditions, providing an objective standard for measuring function. In the same way, the "percent conversion" of NOx can be used to reasonably quantify the function of an SCR catalyst. This information is not provided in the '185 patent.

28. As one example demonstrating the ambiguity of these terms, I cannot tell whether the catalysts disclosed in the Chmielarz article, attached as Exhibit 13 to my declaration, fall within the scope of the "material composition A" term, the "material composition B" terms, all of the terms, or none of them. *Chmielarz et al.*, *Selective oxidation of ammonia to nitrogen on transition metal containing mixed metal oxides*, Applied Catalysis B: Environmental 58 (2005) 235–244. This article, published in 2005, describes research into developing new catalysts to combat the ammonia slip problem. Chmielarz at 235. The type of catalysts studied, transition

metal oxides, are not listed by the '185 patent as suitable catalysts for ammonia oxidation. '185 patent at 8:3-57. Some of these materials were, however, found to be "active catalysts of ammonia oxidation." Chmielarz at 243. Other of the materials "showed poor catalytic performance." Chmielarz at 243. I cannot determine which of the Chmielarz catalysts display enough catalytic activity for ammonia oxidation to be considered a "material composition A" in the '185 patent. Furthermore, the transition metal oxides described in the article also display some degree of SCR activity. Chmielarz at Fig. 9. I cannot determine which of the Chmielarz catalysts display enough SCR activity to be considered a "material composition B" in the '185 patent.

29. Finally, while I do not believe that a skilled person in this field could determine the scope of the "material composition A" and "material composition B" phrases individually, the fact that the '185 patent uses these terms to refer to two separate catalyst compositions adds an additional layer of uncertainty. It is well-known in the catalysis field that some materials are effective to oxidize ammonia under certain conditions and effective to catalyze SCR of NOx under other conditions, or simultaneously exhibit both functions under certain conditions. For example, copper zeolites will oxidize ammonia at elevated temperatures within the normal range of operating conditions, in addition to catalyzing the SCR of NOx. '185 patent at 12:45-48. If the copper zeolite material is considered a "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" as described in claim 1, it is unclear whether that material can also be a "material composition A effective for catalyzing NH3 oxidation" within that claim. In other words, under conditions where copper zeolites can catalyze both reactions, it is unclear whether or not a catalyst system where both of the two separate catalyst compositions are copper-containing SCR catalysts are encompassed within claim 1. In my opinion, this is an additional reason why a person of skill in this field could not determine with reasonable certainty which materials are included within "material composition A effective for catalyzing NH3 oxidation" and "material composition B effective to catalyze selective catalytic reduction (SCR) of NOx" based on the disclosure in the '185 patent.

IV. OPINIONS REGARDING THE "OVERCOAT WASHCOAT" PHRASES IN CLAIMS 1 AND 17

30. I understand that JMI and BASF dispute the meaning of the following phrases in claims 1 and 17 of the '185 patent:

(a) "an overcoat washcoat layer coated over a total length of the monolithic substrate from the inlet end to the outlet end" (Claim 1);

(b) "an overcoat washcoat layer coated over a total length of the honeycomb substrate from the inlet end to the outlet end of the substrate" (Claim 17).

31. In the catalysis field, a washcoat layer is commonly understood to be any continuous layer of the same material composition. A single washcoat layer can be made by applying one coating of material, or by applying multiple coatings of the same material.

32. Calcination is a process by which a catalyst material is activated after application and can also be used to fix the catalyst to the substrate. This process removes, through oxidation, residual material used to prepare the catalyst. It decomposes precursor materials, with the end result leaving the catalyst particle constituent in place, "fixed" to the support material.

33. For a number of different reasons, it is often necessary to repeat the coating and calcination steps. As the '185 patent explains, it is sometimes necessary to apply multiple coatings of the same catalyst composition in order to get enough of the catalyst onto the substrate. '185 patent at 10:4-34. The multiple coatings can be applied sequentially, and then calcined. Alternatively, the catalyst composition can be calcined between coating steps—*i.e.*, after the first coating step, the substrate is calcined, then a second coating is applied and the substrate is calcined again. '185 patent at 10:28-30 ("The coating, drying, and calcination processes may be repeated if necessary to achieve the final desired gravimetric amount of the catalyst washcoat layer on the support."). In either case, the result is a single washcoat of the same material composition. As used in this field, the term "washcoat layer" includes washcoats that have been calcined only one time, and washcoats made with multiple application and calcination steps.

34. Likewise, a single washcoat can be made from coating and calcining different portions of the substrate at different times. For example, the inlet end of the substrate could be coated and calcined, followed by the outlet end being coated and calcined with the same material composition. If the two coatings adjoin or overlap, this is considered a single washcoat layer. It is a single, continuous layer of the same material composition.

35. The term "washcoat layer" conveys that the layer is made up of a distinct material composition, not that it has been prepared in any specific way in terms of the coating, drying, and calcining steps. The '185 patent states that "a washcoat layer consists of a compositionally distinct layer of material disposed on the surface of the monolithic substrate or an underlying washcoat layer." '185 patent at 5:8-17. I agree with this description of a washcoat layer.

36. The '185 patent describes an example of a single washcoat that has been created through what I believe were multiple coating and calcination steps. Specifically, the '185 patent describes Example IH as having been prepared through "three coating steps," thus creating an "evident … boundary between the layers." '185 patent at 15:20-37 (Example 1). The patent says, however, that this is still a single "washcoat"—*i.e.*, that "these do not constitute boundaries between different compositions, however, and so catalyst 1H does not fit the present definition of a layered catalyst." '185 patent at 15:20-37. Figure 4(a) of the patent indicates that these three application steps created visible boundaries within the washcoat:

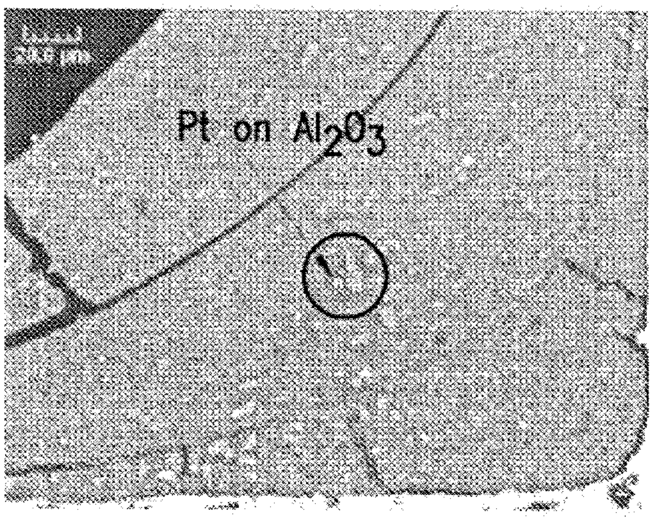

FIG. 4(a)

37. The ’185 patent does not expressly state whether each of the three coating steps included calcination. Regardless of whether this catalyst was calcined after each coating step, or only once after all coating steps were complete, in my opinion this describes, and Figure 4(a) shows, a single washcoat because the result is single, continuous layer of the same material composition.

38. In my opinion, the term a “washcoat layer” has no requirement that the catalyst composition have a uniform thickness the length of the substrate. Instead, a single washcoat layer can have a thickness (or “washcoat loading”) that varies across the length of the substrate. For example, even where there is more catalyst composition loaded into the inlet end of the substrate than there is of the same catalyst composition loaded into the outlet end, that is still considered a single washcoat layer. In fact, I develop catalysts where the same material composition has a thickness that forms a gradient across the length of the substrate. I still consider this a single “washcoat layer.”

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed this 19th day of November, 2015, at Houston, Texas.

William S. Epling, Ph.D.